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Eveker et al.

(54) SPOILER FOR AN AIRCRAFT BAY

(71) Applicant: **The Boeing Company**, Chicago, IL (US)

(72) Inventors: **James Vincent Eveker**, St. Louis, MO (US); **Patrick Dale Huhman**, St. Peters, MO (US); **Cindy Lee Crites**, O'Fallon, MO (US)

(73) Assignee: **The Boeing Company**, Chicago, IL (US)

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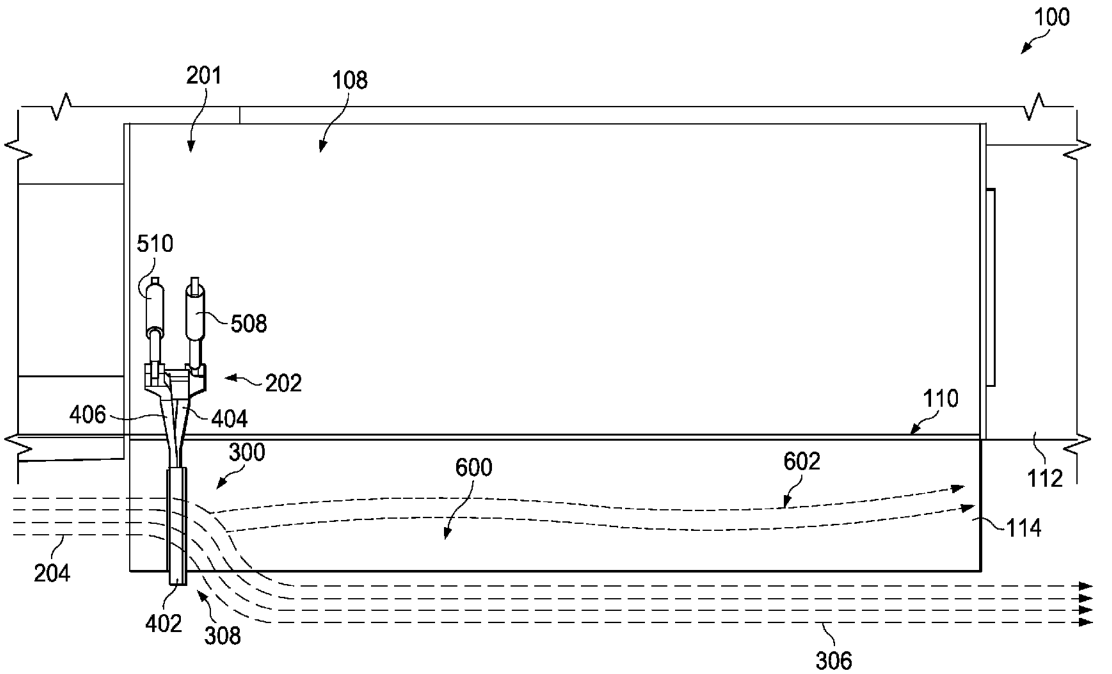
CPC *B64C 5/12* (2013.01); *B64C 23/005* (2013.01)

(57) **ABSTRACT**

A method for managing an airflow of an aircraft. A spoiler is moved into the airflow passing a bay of the aircraft when the bay is open. The airflow moving relative to the bay is changed to form a desired airflow using louvers physically associated with a frame system in the spoiler.



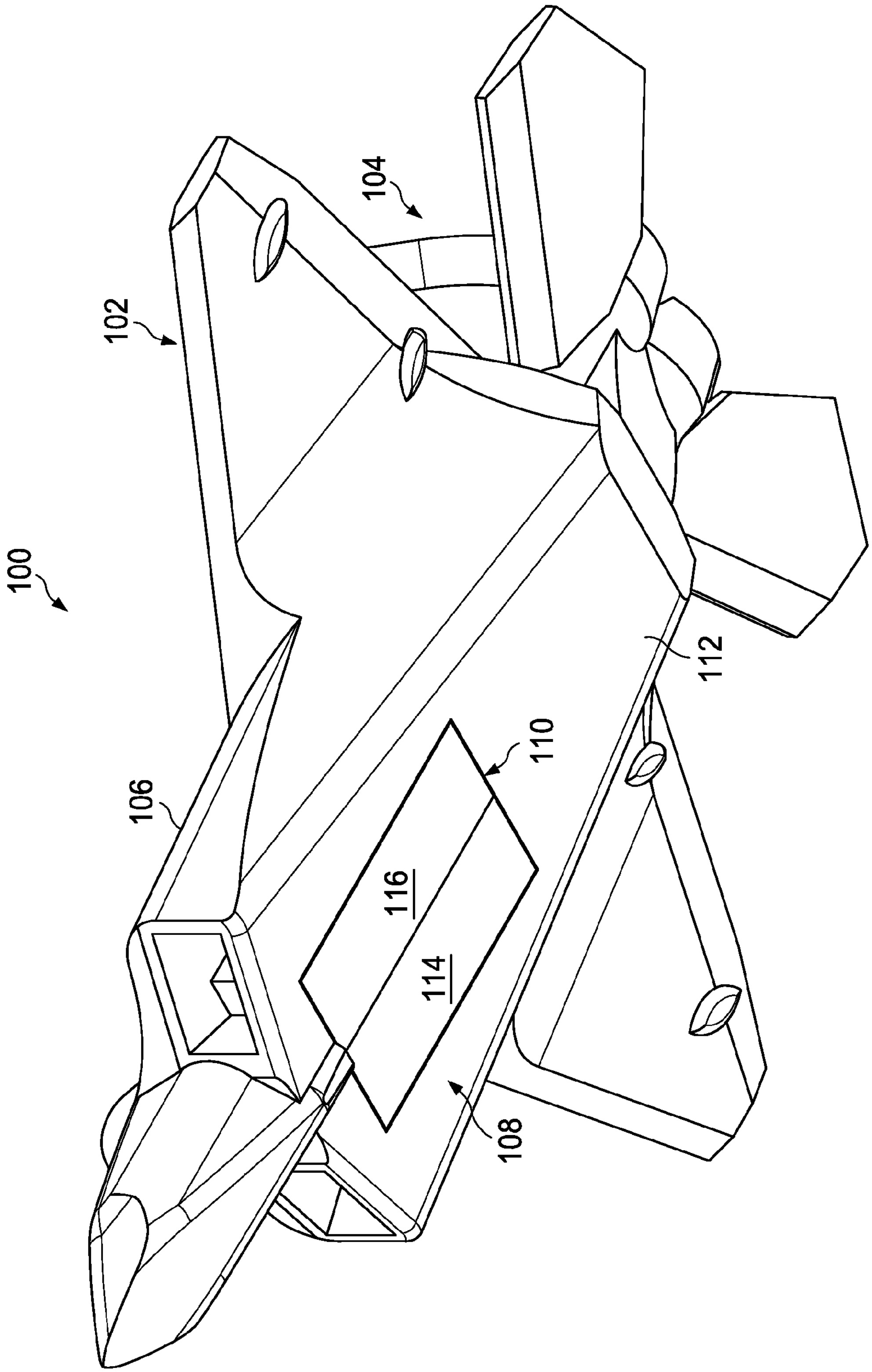


FIG. 1

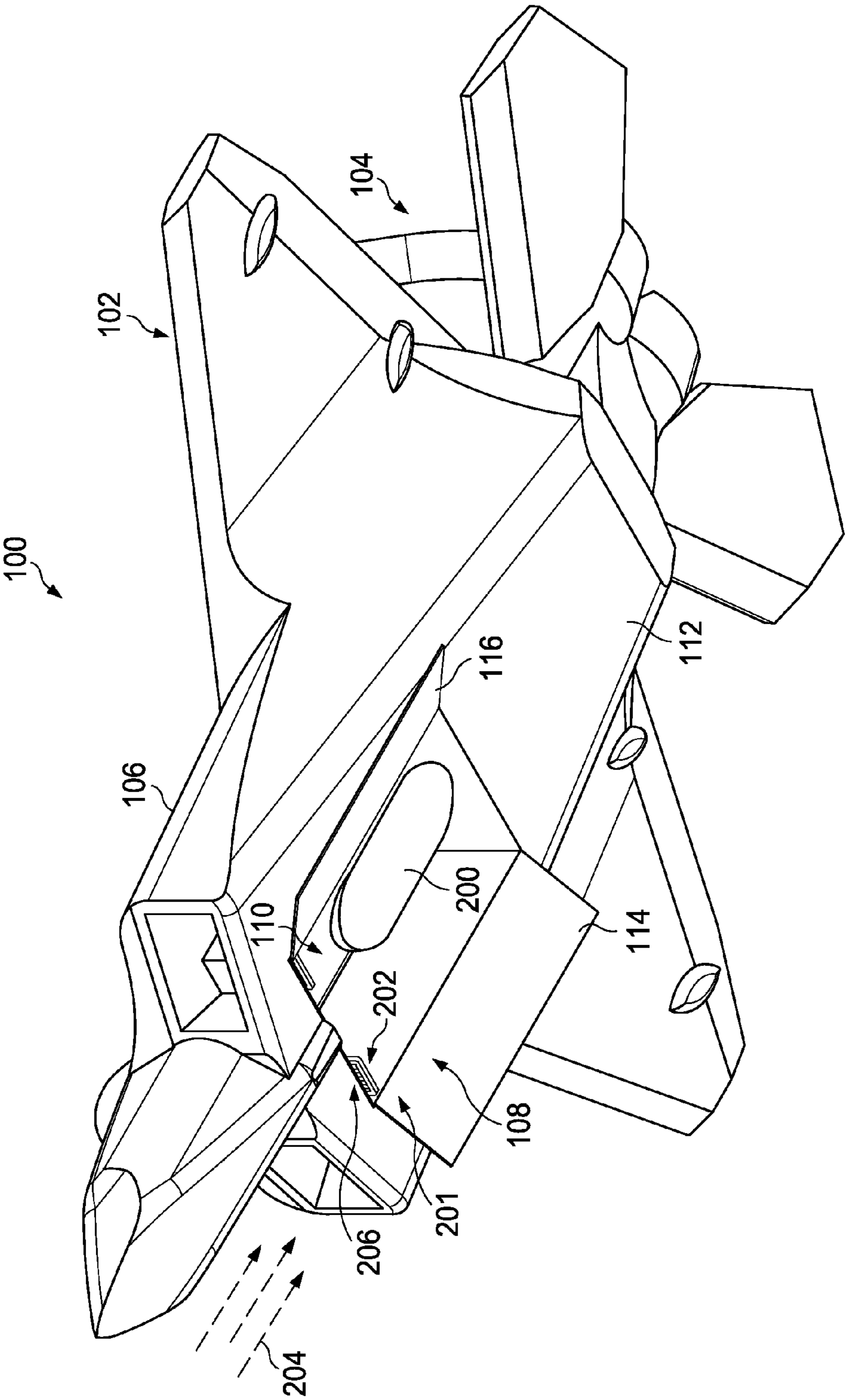


FIG. 2

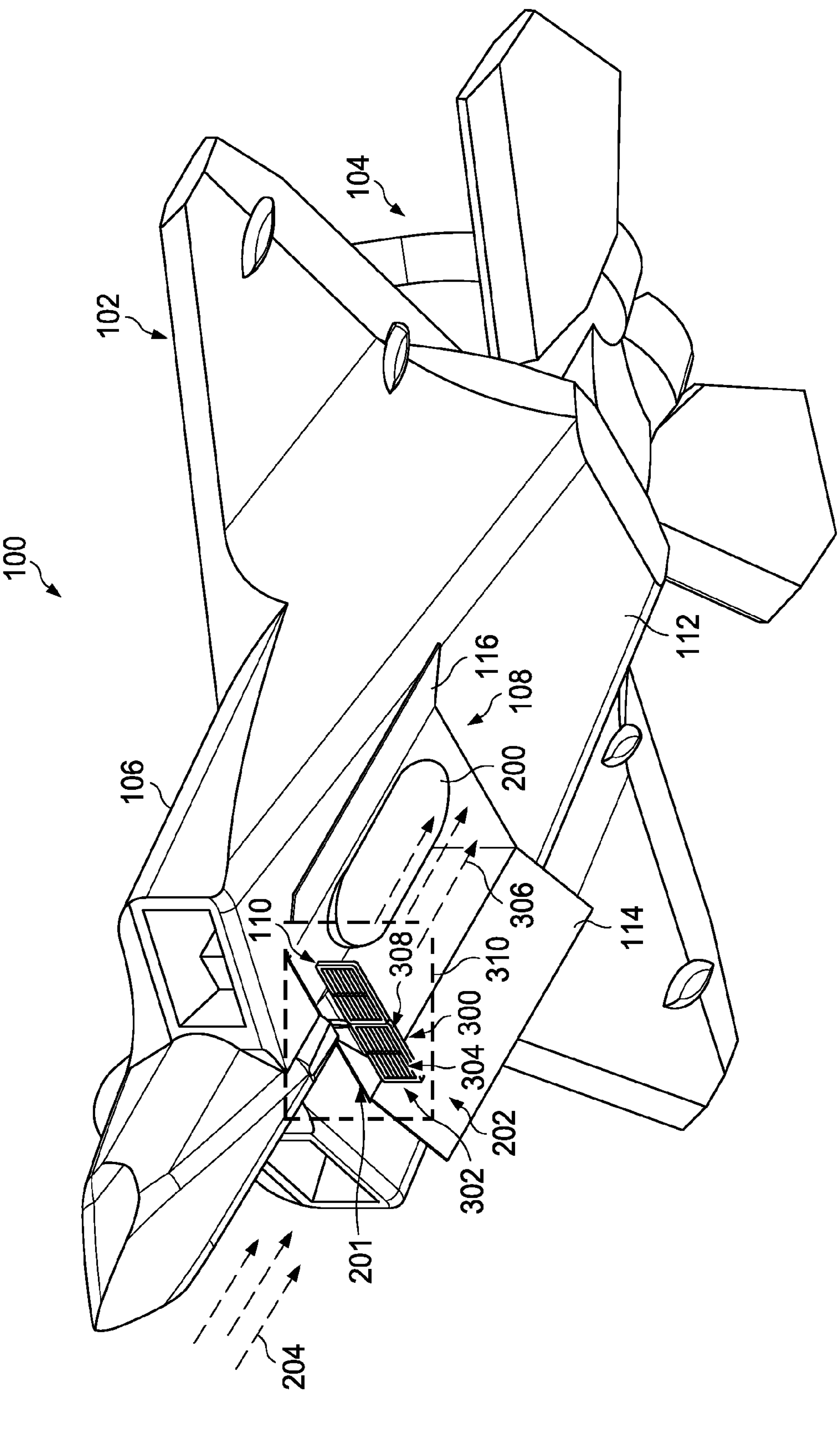

100
102
104
106
108
110
112
114
116
200
201
202
204
300
302
304
306
308
310

FIG. 3

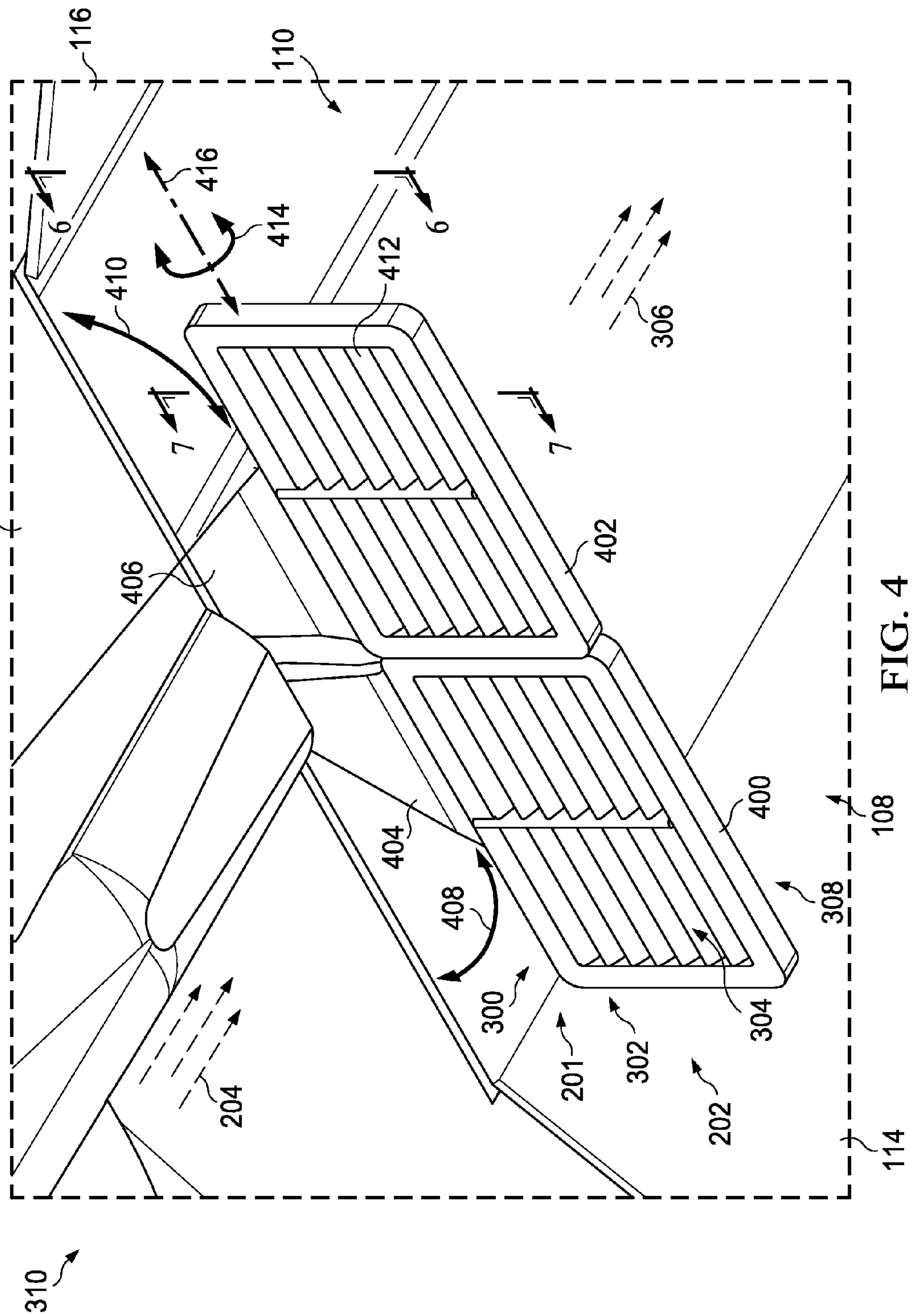

116
110
416
414
412
410
6
6
306
7
7
112
406
402
404
400
108
408
308
300
304
302
201
202
204
114
310

FIG. 4

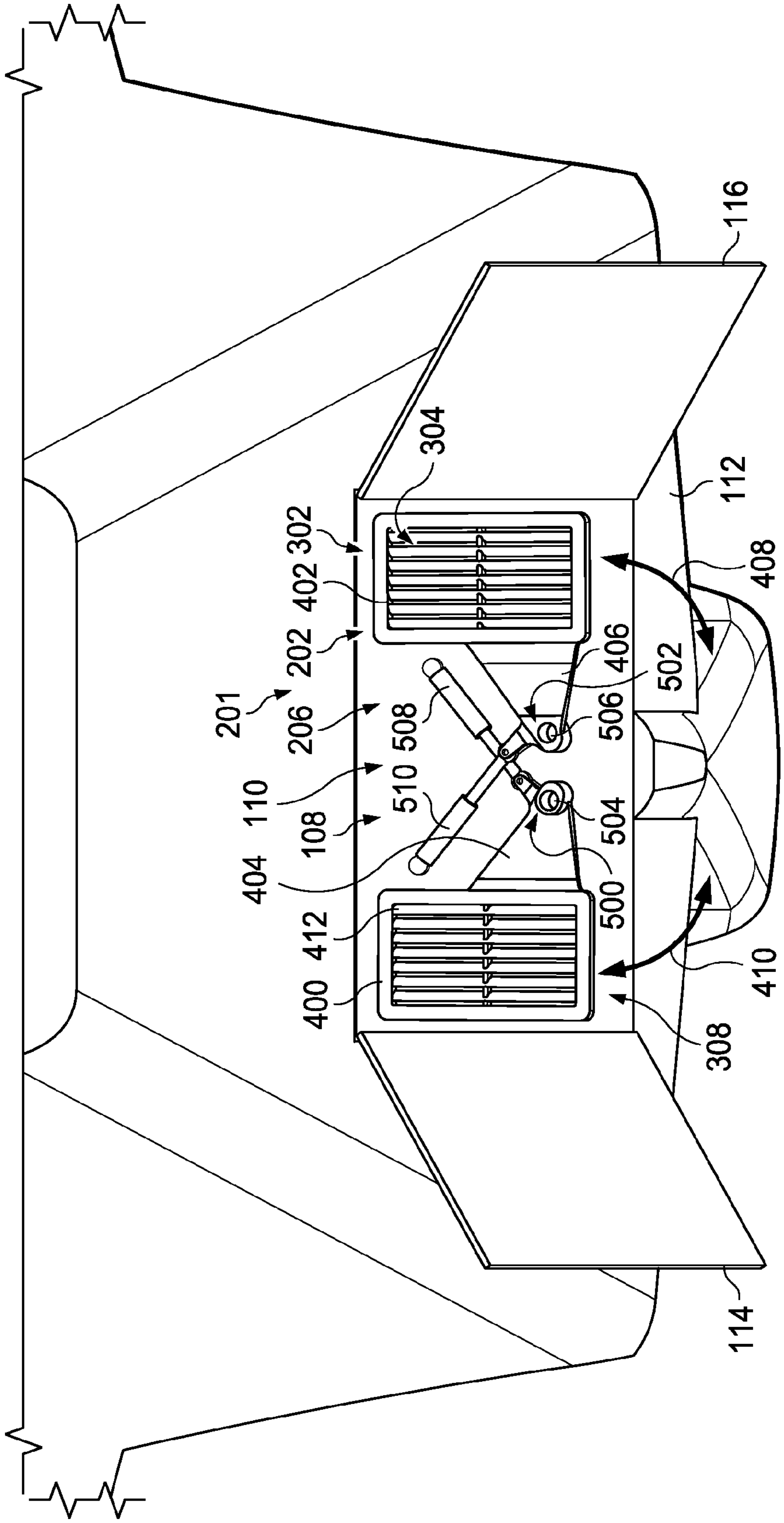

201
206
202
402
302
304
110
108
510
508
404
412
400
506
406
502
504
500
116
112
408
410
308
114

FIG. 5

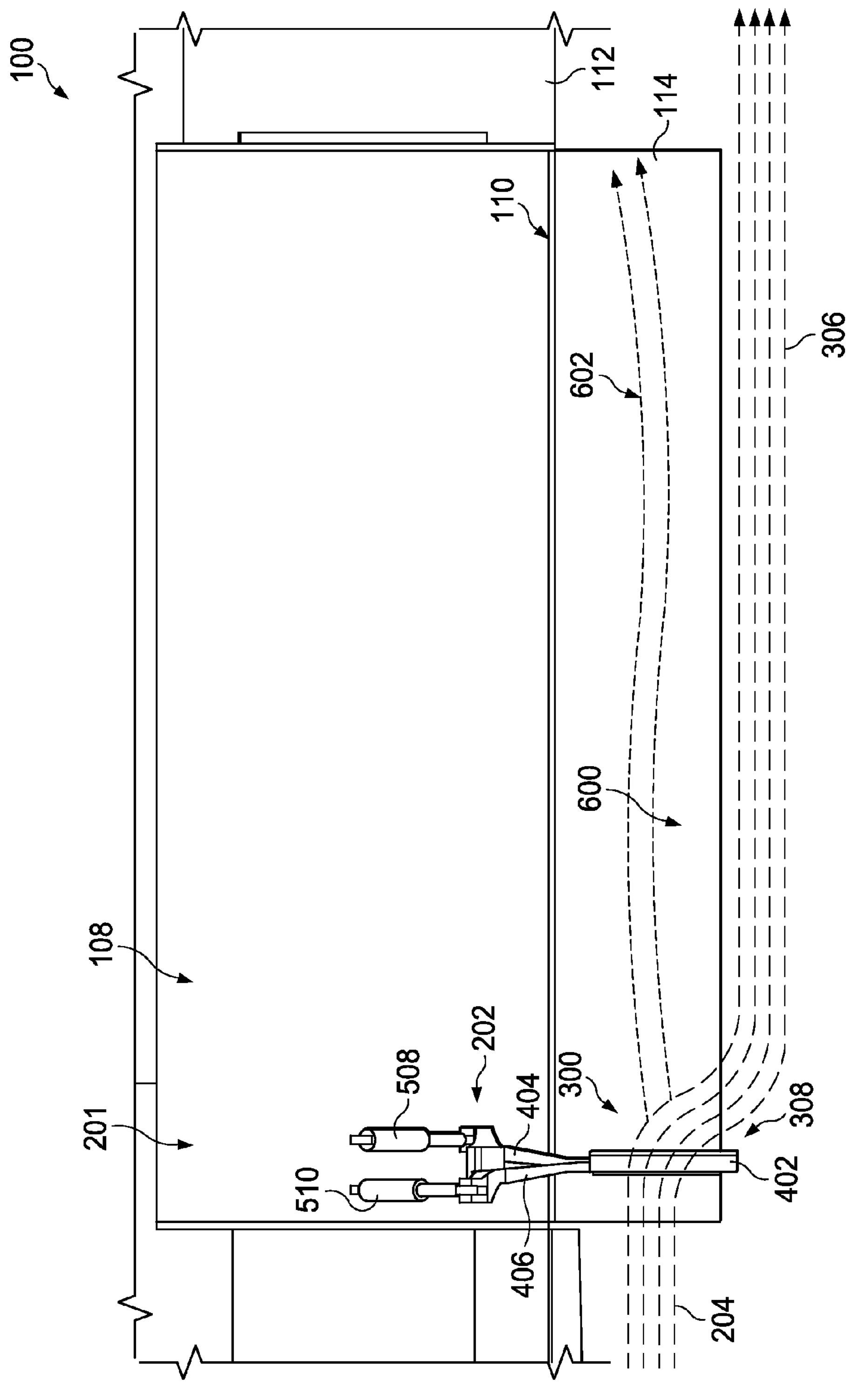

100
112
114
110
306
602
600
108
202
508
404
300
308
201
510
402
406
204

FIG. 6

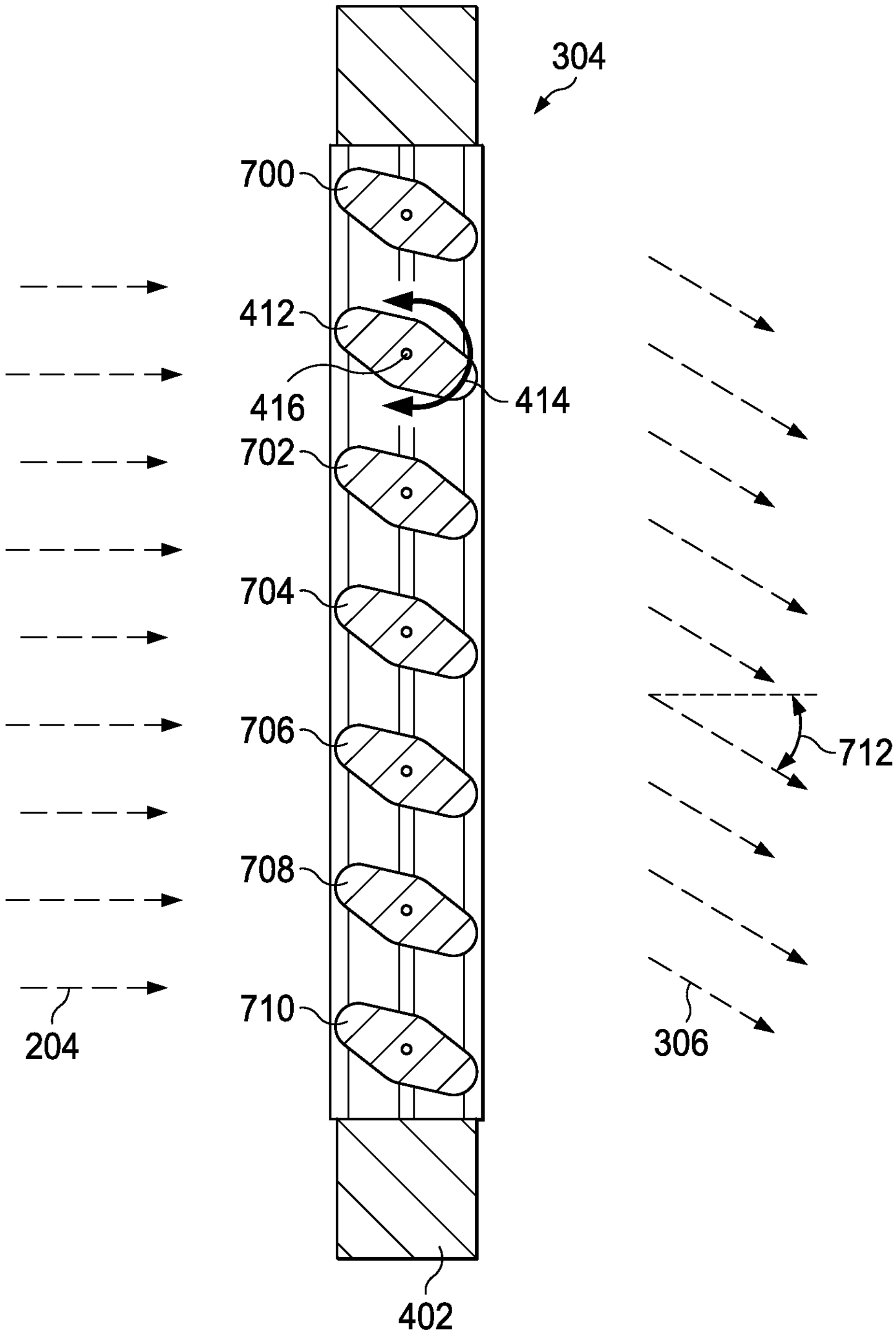


FIG. 7

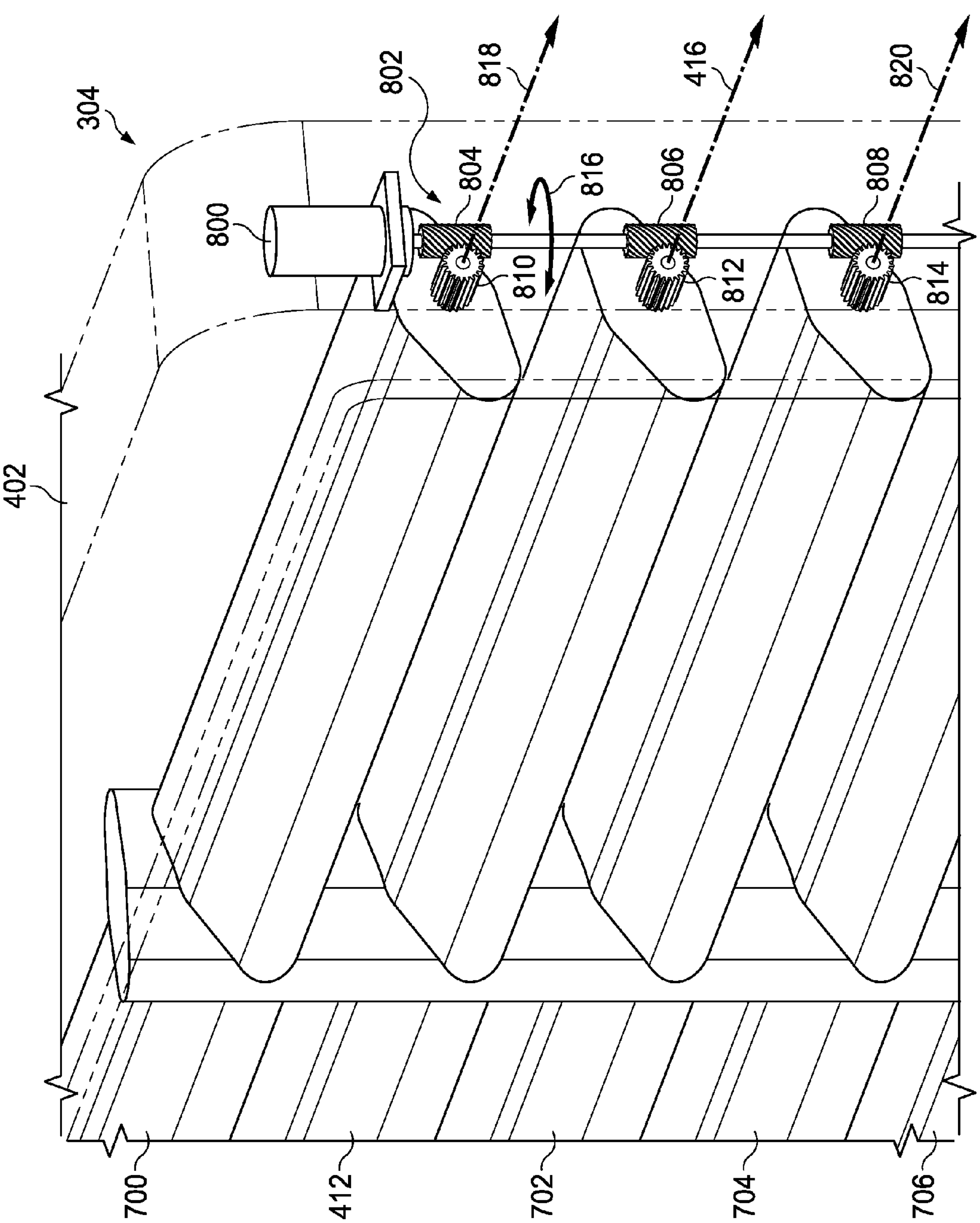

304
402
800
802
804
806
808
810
812
814
816
818
416
820
700
412
702
704
706

FIG. 8

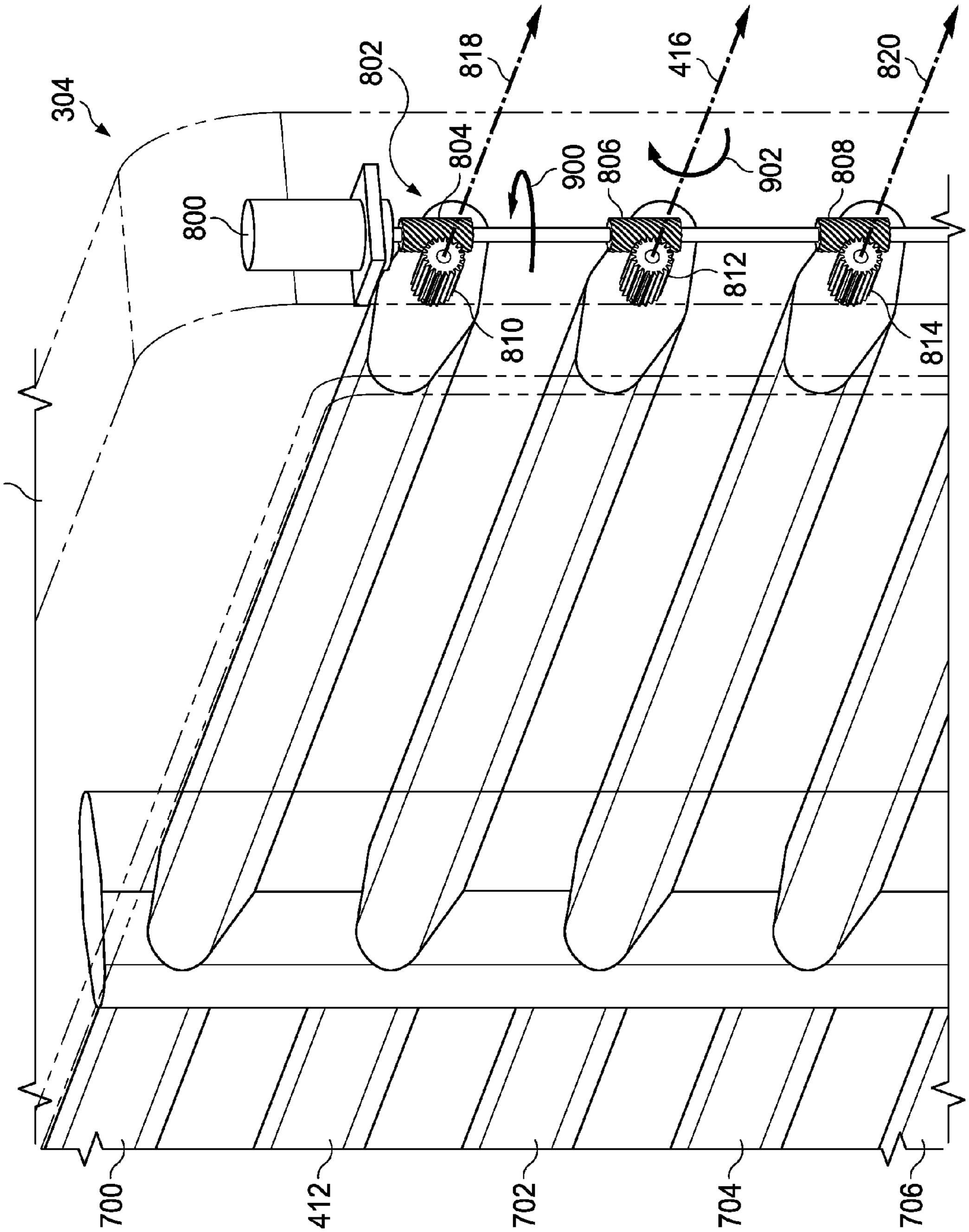

304
402
802
818
416
820
800
804
900
806
902
808
810
812
814
700
412
702
704
706

FIG. 9

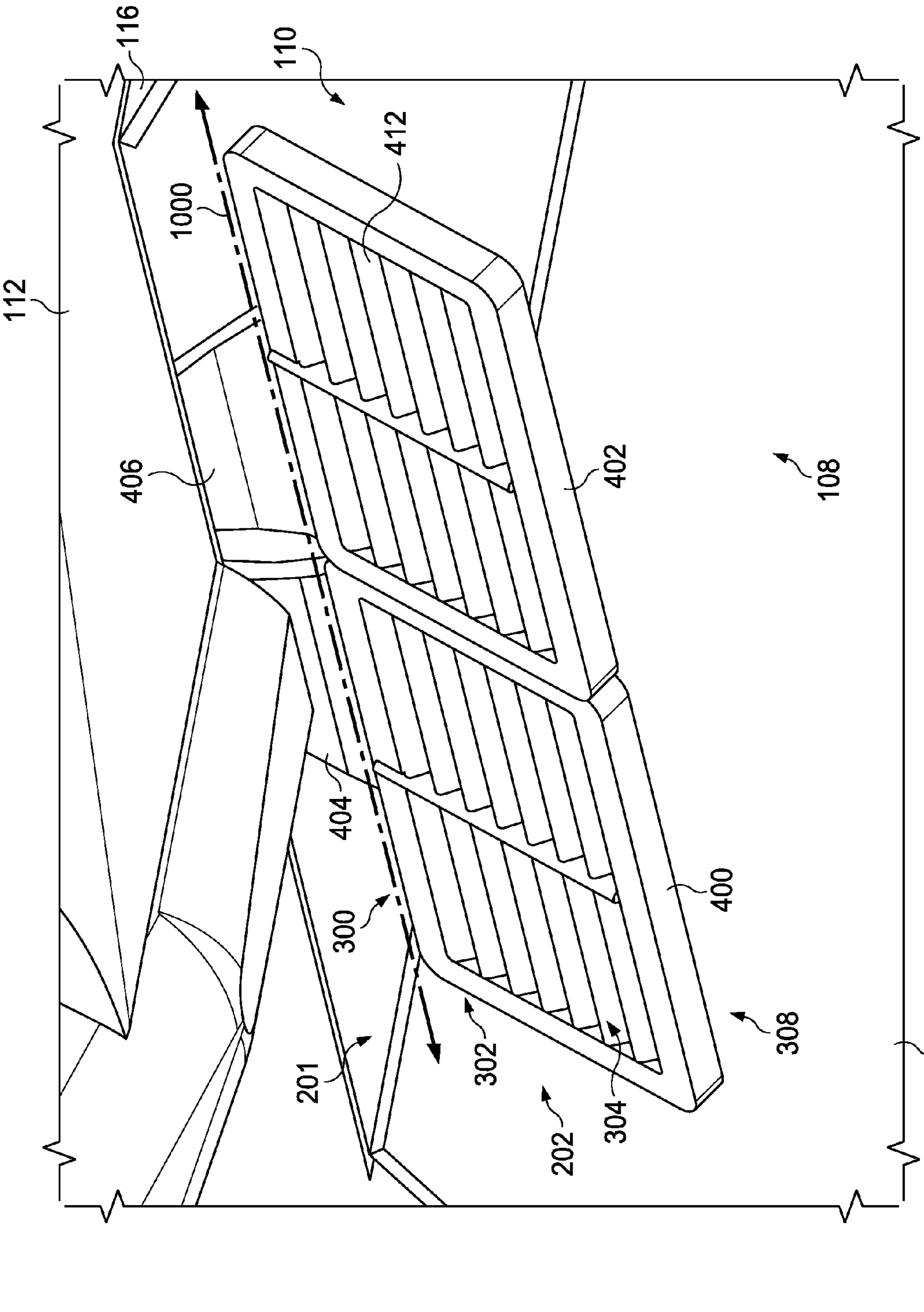

116
110
112
412
1000
406
402
108
404
400
300
201
302
308
202
304
114

FIG. 10

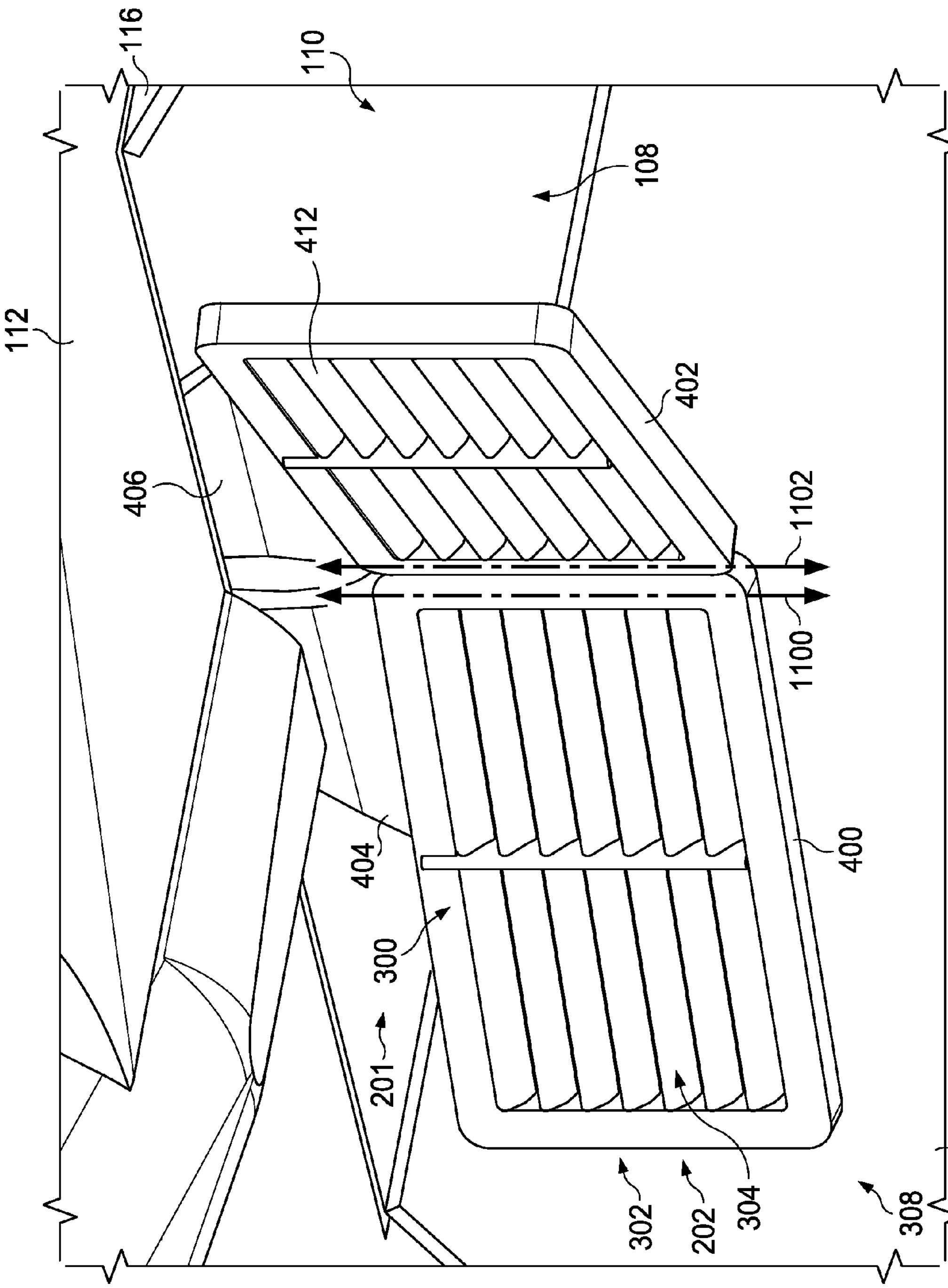

116
110
108
112
412
402
406
1102
1100
404
400
300
201
304
302
202
308
114

FIG. 11

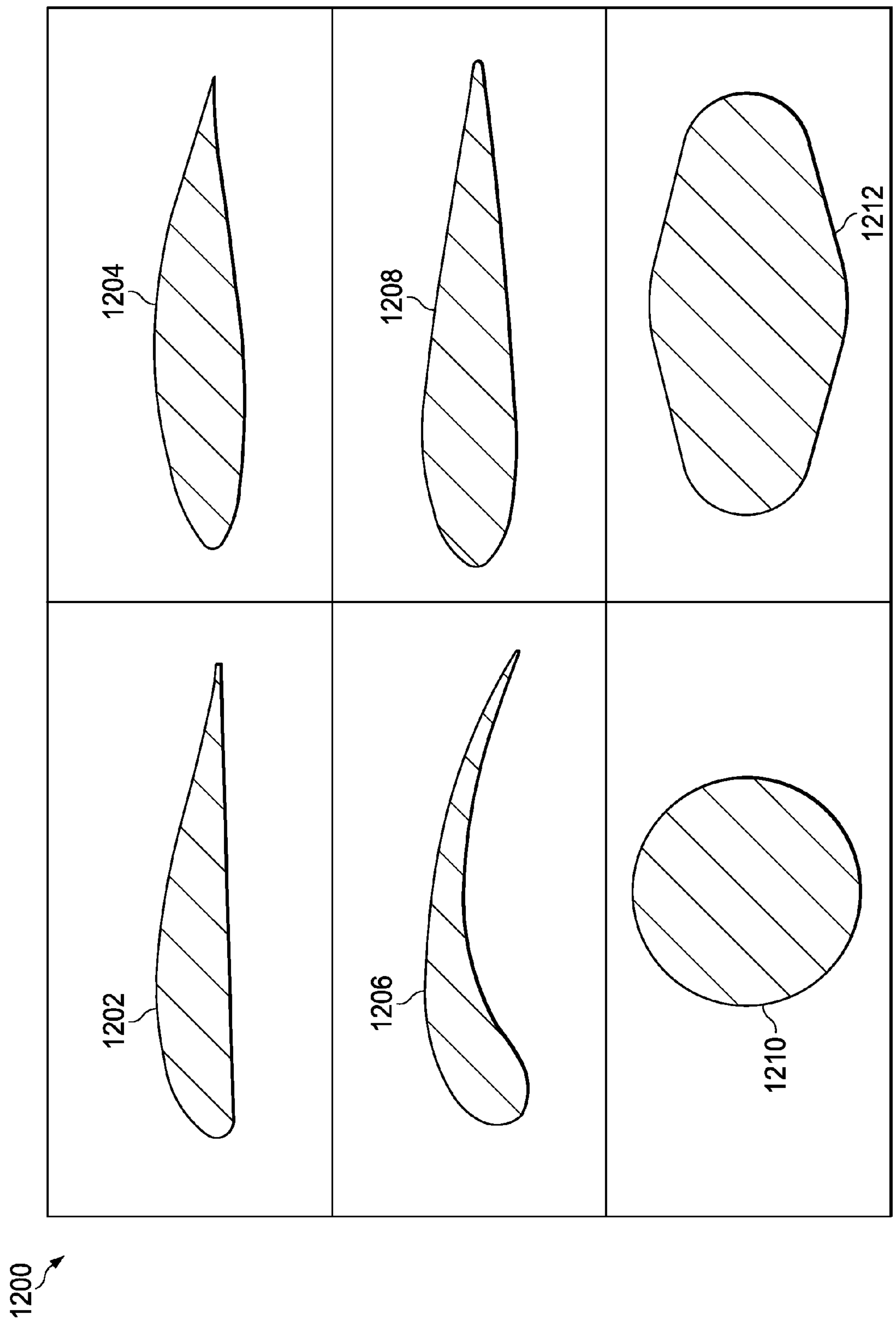


FIG. 12

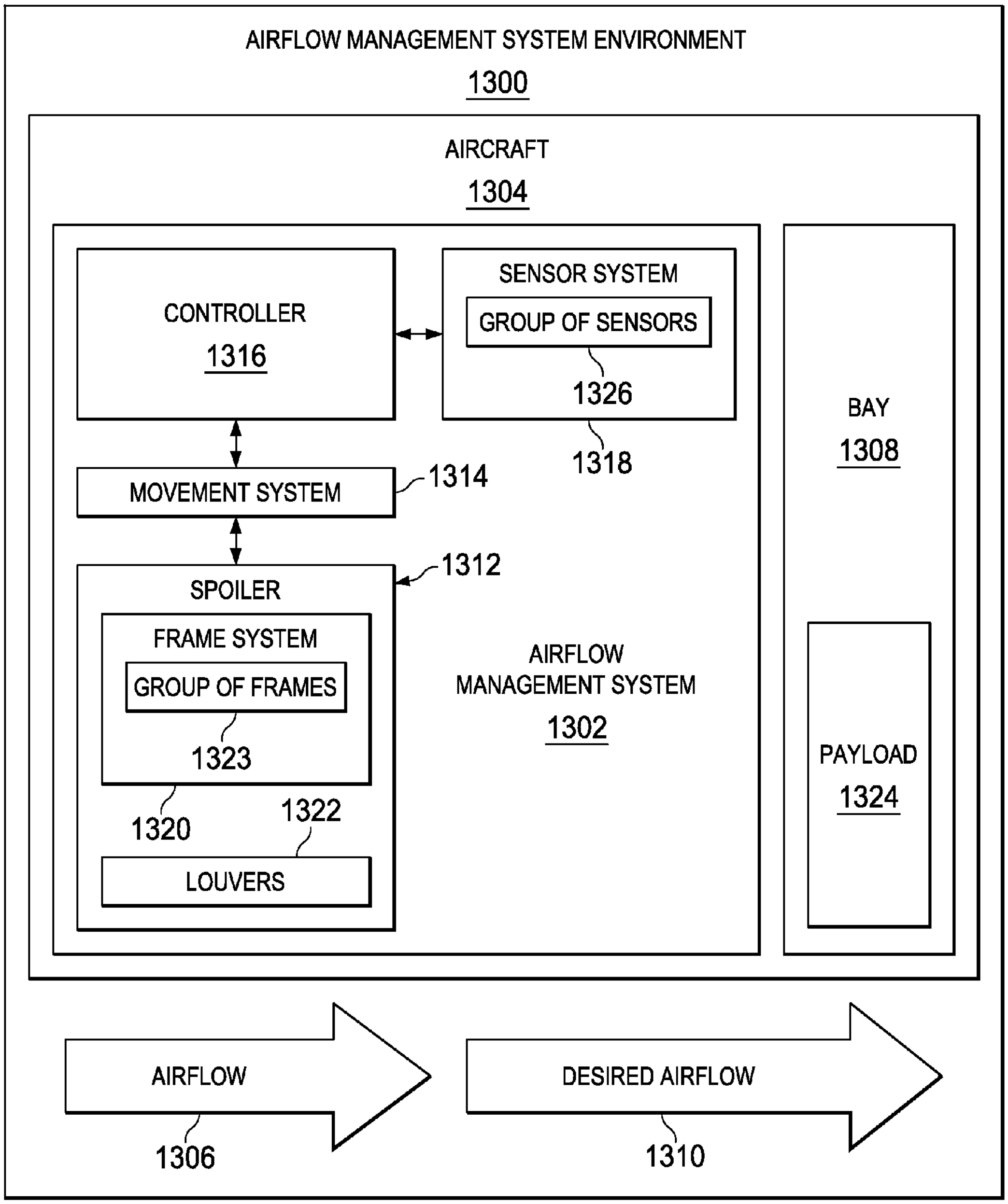

AIRFLOW MANAGEMENT SYSTEM ENVIRONMENT
1300
AIRCRAFT
1304
CONTROLLER
1316
SENSOR SYSTEM
GROUP OF SENSORS
1326
1318
MOVEMENT SYSTEM
1314
1312
SPOILER
FRAME SYSTEM
GROUP OF FRAMES
1323
1320
1322
LOUVERS
AIRFLOW
MANAGEMENT SYSTEM
1302
BAY
1308
PAYLOAD
1324
AIRFLOW
1306
DESIRED AIRFLOW
1310

FIG. 13

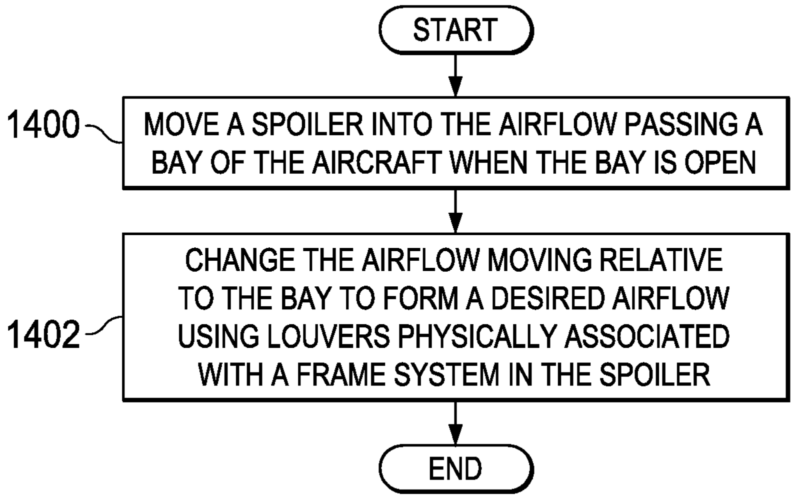

START
1400
MOVE A SPOILER INTO THE AIRFLOW PASSING A BAY OF THE AIRCRAFT WHEN THE BAY IS OPEN
1402
CHANGE THE AIRFLOW MOVING RELATIVE TO THE BAY TO FORM A DESIRED AIRFLOW USING LOUVERS PHYSICALLY ASSOCIATED WITH A FRAME SYSTEM IN THE SPOILER
END

FIG. 14

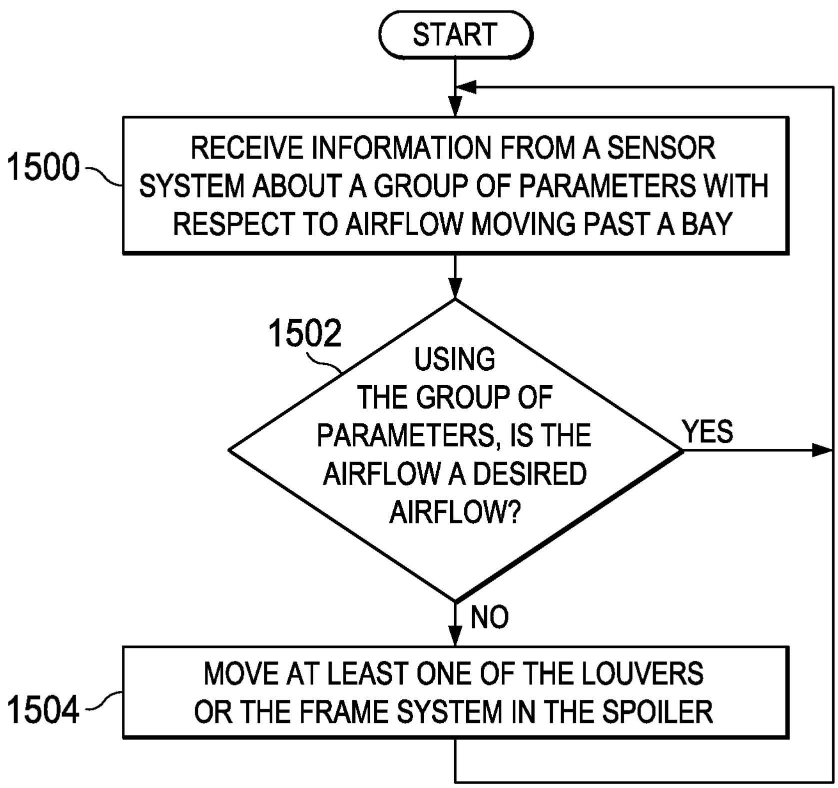

START
1500
RECEIVE INFORMATION FROM A SENSOR SYSTEM ABOUT A GROUP OF PARAMETERS WITH RESPECT TO AIRFLOW MOVING PAST A BAY
1502
USING THE GROUP OF PARAMETERS, IS THE AIRFLOW A DESIRED AIRFLOW?
YES
NO
1504
MOVE AT LEAST ONE OF THE LOUVERS OR THE FRAME SYSTEM IN THE SPOILER

FIG. 15

FIG. 16

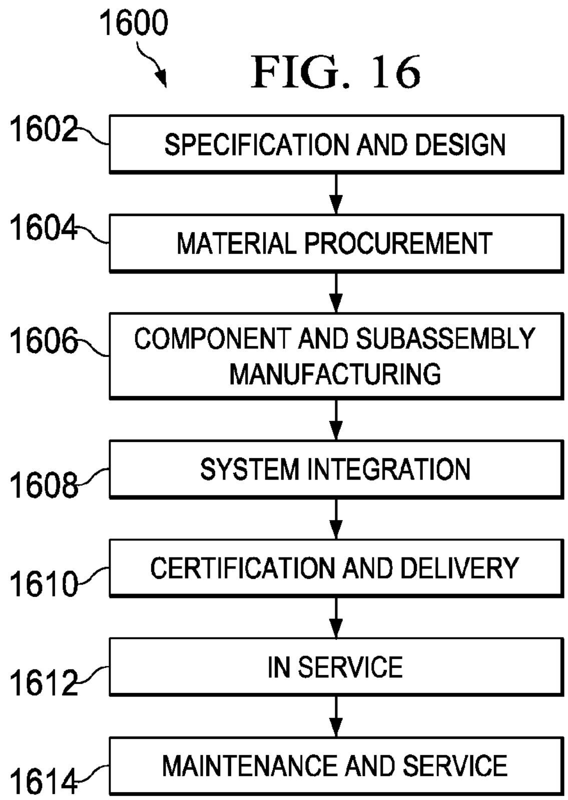
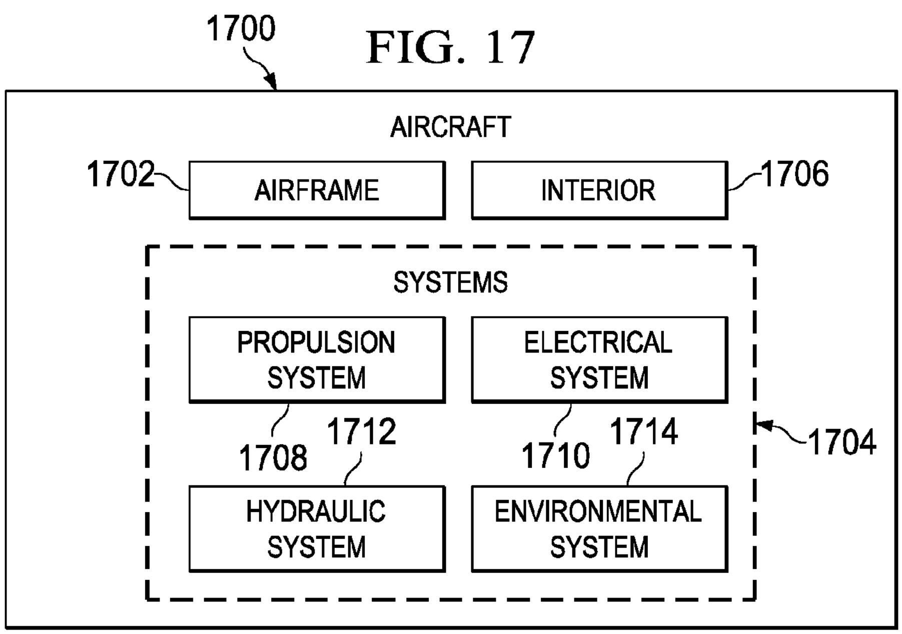

1600
1602
SPECIFICATION AND DESIGN
1604
MATERIAL PROCUREMENT
1606
COMPONENT AND SUBASSEMBLY MANUFACTURING
1608
SYSTEM INTEGRATION
1610
CERTIFICATION AND DELIVERY
1612
IN SERVICE
1614
MAINTENANCE AND SERVICE

FIG. 17


1700
AIRCRAFT
1702
AIRFRAME
INTERIOR
1706
SYSTEMS
PROPULSION SYSTEM
ELECTRICAL SYSTEM
1708
1712
1710
1714
1704
HYDRAULIC SYSTEM
ENVIRONMENTAL SYSTEM

SPOILER FOR AN AIRCRAFT BAY

BACKGROUND INFORMATION

[0001] 1. Field

[0002] The present disclosure relates generally to aircraft and, in particular, to an airflow management system. Still more particularly, the present disclosure relates to a method and apparatus for managing an airflow moving past a bay in an aircraft

[0003] 2. Background

[0004] Many types of aircraft have one or more bays that may open during different phases of flight. For example, military aircraft may have a weapons bay on the underside of the fuselage of the military aircraft. The weapons bay may be a cavity or a space inside the military aircraft that is covered by one or more doors. The weapons bay allows for the deployment of a payload located within the weapons bay. The payload may be, for example, equipment, stores, munitions, other types of payload.

[0005] When the doors of the weapons bay are closed, the surface of the aircraft has a desired shape and smoothness that enhances aerodynamic performance as well as other characteristics of the aircraft. Other characteristics may include, for example, stealthiness of the aircraft. When the doors of the weapons bay are open during flight, the airflow does not move over the aircraft in a desired manner. Instead, the opening of the doors often results in an unstable airflow that buffets aircraft structures, the payload, or both.

[0006] For example, when the doors are open, a region called a shear layer is created such that the airflow abruptly transitions from a low speed flow of air inside of a cavity to high speed flow of air outside of the cavity of the weapons bay. This shear layer may result in rotating pockets of airflow referred to as vortices. The vortices remain on the aft wall of the cavity causing vibrations.

[0007] The vibrations may cause undesired noise in the weapons bay. For example, the vibrations may result in high levels of resonance and acoustic levels within the weapons bay. These vibrations may adversely affect the structures or parts of the aircraft such that the aircraft does not perform in a desired manner.

[0008] An undesired noise may reduce performance characteristics such as stealthiness of the aircraft and may result in needed aircraft structures that have increases in weight, which also reduce aircraft performance. Further, the unstable airflow may cause a payload that is separating from the aircraft to become uncontrollable or contact the aircraft after release. This type of contact may cause inconsistencies in the structure of the aircraft, cause the payload to perform in an undesired manner, or result in some other undesirable event. For example, the payload may become uncontrollable with respect to directing the payload to a target even if contact does not happen with the aircraft. For example, a payload being delivered to a location on the ground may be released and designed to have a trajectory to reach the location. If the payload becomes uncontrollable, contacts the aircraft, or both after being released, then the payload may not follow the trajectory needed to reach the location.

[0009] A spoiler may be used to reduce this undesired airflow. Currently used spoilers, however, may generate more turbulence than desired in the airflow while attempting to reduce undesired noise in the weapons bay. This type of turbulence may not provide a desired level of performance for different characteristics of the aircraft.

[0010] Therefore, it would be desirable to have a method and apparatus that take into account at least some of the issues discussed above, as well as other possible issues.

SUMMARY

[0011] An embodiment of the present disclosure provides an apparatus. The apparatus comprises a frame system and louvers. The frame system is configured to move relative to a bay in an aircraft. The louvers are physically associated with the frame system. The louvers are configured to change an airflow moving relative to the bay when the bay is open to form a desired airflow.

[0012] Another embodiment of the present disclosure provides an aircraft airflow management system comprising a group of frames and louvers. The group of frames are configured to move between a stowed position in a bay of the aircraft and an active position outside the bay of the aircraft. The louvers are physically associated with the group of frames. The louvers are configured to change an airflow relative to the bay after the louvers are in the airflow outside of the bay in a desired manner when the bay is open to form a desired airflow and the group of frames are in the active position. The desired airflow results in at least one of a desired level of noise, preventing a payload from becoming uncontrollable, or avoiding contact between the aircraft and the payload exiting the bay of an aircraft in flight.

[0013] Yet another embodiment of the present disclosure provides a method for managing an airflow for an aircraft. A spoiler is moved into the airflow passing a bay of the aircraft when the bay is open. The airflow moving relative to the bay is changed to form a desired airflow using louvers physically associated with a frame system in the spoiler.

[0014] The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

[0016] FIG. **1** is an illustration of an aircraft in accordance with an illustrative embodiment;

[0017] FIG. **2** is an illustration of an aircraft with a bay in an open position in accordance with an illustrative embodiment;

[0018] FIG. **3** is an illustration of an airflow management system for an aircraft in accordance with an illustrative embodiment;

[0019] FIG. **4** is an illustration of an enlarged view of a frame system in accordance with an illustrative embodiment;

[0020] FIG. **5** is an illustration of a portion of a frame system in accordance with an illustrative embodiment;

[0021] FIG. **6** is an illustration of a laminar airflow redirected in a desired direction in accordance with an illustrative embodiment;

[0022] FIG. **7** is an illustration of a cross-section of louvers in a portion of a frame in accordance with an illustrative embodiment;

[0023] FIG. **8** is an illustration of a movement system in accordance with an illustrative embodiment;

[0024] FIG. **9** is an illustration of a movement system in accordance with an illustrative embodiment;

[0025] FIG. **10** is an illustration of a frame that moves about an axis in accordance with an illustrative embodiment;

[0026] FIG. **11** is another illustration of a frame that moves about another axis in accordance with an illustrative embodiment;

[0027] FIG. **12** is an illustration of cross-sections of louvers in accordance with an illustrative embodiment;

[0028] FIG. **13** is an illustration of an airflow management system in the form of a block diagram in accordance with an illustrative embodiment;

[0029] FIG. **14** is an illustration of a flowchart of a process for managing airflow for an aircraft in accordance with an illustrative embodiment;

[0030] FIG. **15** is an illustration of a flowchart of a process for managing an airflow for an aircraft using an airflow management system in accordance with an illustrative embodiment;

[0031] FIG. **16** is an illustration of an aircraft manufacturing and service method in the form of a block diagram in accordance with an illustrative embodiment; and

[0032] FIG. **17** is an illustration of an aircraft in the form of a block diagram in which an illustrative embodiment may be implemented.

DETAILED DESCRIPTION

[0033] The illustrative embodiments recognize and take into account one or more different considerations. For example, the illustrative embodiments recognize and take into account that currently used devices introduced into an airflow moving past a bay in an aircraft often cause more turbulence than desired. The illustrative embodiments also recognize and take into account that currently used spoilers are static in design. In other words, the illustrative embodiments recognize and take into account that a spoiler for the bay of an aircraft may be designed to take into account the characteristics of the bay and the payload.

[0034] The illustrative embodiments recognize and take into account that a spoiler designed for a particular bay and payload may not perform as well in reducing undesired airflow when placed in a different bay. Further, even when used in the same bay, when the payload is changed, the spoiler may not reduce undesired airflow as much as desired.

[0035] Further, the illustrative embodiments recognize and take into account that currently used spoilers are unable to dynamically adapt to changes in the environment around the aircraft or changes within the bay cavity during flight. This may include, for example, different speeds, altitudes, temperatures, and other environmental parameters that may change. As another example when objects are sequentially released over time, the configuration of the cavity changes, which may change the manner in which air flows in the cavity. In other words, when objects are released the manner in which airflows in the cavity may change. With these types of changes, the illustrative embodiments recognize and take into account that a spoiler may not change the airflow in a desired manner to avoid reductions in performance, noise generated by the airflow, or both.

[0036] Thus, the illustrative embodiments provide a method and apparatus for managing an airflow for an aircraft. In one illustrative example, an apparatus comprises a frame system and louvers. These components form a spoiler. The frame system is configured to move relative to a bay in an aircraft. The louvers are physically associated with the frame system and are configured to change an airflow moving relative to the bay when the bay is open to form a desired airflow. In the illustrative examples, the change in the airflow is in a direction relative to the surface of the aircraft. This change in airflow may result in undesired airflow in which turbulence, vortices, and other undesirable types of airflow are reduced.

[0037] With reference now to the figures and, in particular, with reference to FIG. **1**, an illustration of an aircraft is depicted in accordance with an illustrative embodiment. In this depicted example, aircraft **100** is shown. As depicted, aircraft **100** is a tactical fighter having wings **102**, tail **104**, and fuselage **106**.

[0038] In this illustrative example, aircraft **100** has bay **108** in the form of a weapons bay in fuselage **106**. In this illustrative example, opening **110** for bay **108** is located on lower outer mold line **112** of aircraft **100**. Opening **110** is covered by door **114** and door **116** in this illustrative example.

[0039] As depicted, outer mold line **112** is designed to provide one or more desired performance parameters for aircraft **100**. These performance parameters may include, for example, one or more of stealthiness, drag, noise, fuel efficiency, and other suitable types of parameters regarding the performance of aircraft **100**.

[0040] Turning to FIG. **2**, an illustration of an aircraft with a bay in an open position is depicted in accordance with an illustrative embodiment. In this illustrative example, door **114** and door **116** are in an open position exposing opening **110** in bay **108**. In this view of aircraft **100**, payload **200** is seen in cavity **201** in bay **108**. Payload **200** is one or more objects that may be separated from aircraft **100**. Payload **200** may take various forms. For example, payload **200** may be equipment, sensors, supplies, munitions, weapons, and other suitable types of payload.

[0041] Also seen in this view is airflow management system **202**. Airflow management system **202** is used to manage airflow **204** moving relative to bay **108** when bay **108** is open. As shown, airflow management system **202** is in stowed position **206**.

[0042] With reference next to FIG. **3**, an illustration of an airflow management system for an aircraft is depicted in accordance with an illustrative embodiment. As depicted, airflow management system **202** is shown in active position **300**. In particular, frame system **302** in airflow management system **202** is configured to move between stowed position **206** and active position **300**.

[0043] In this example, louvers **304** are shown as physically associated with frame system **302**. Louvers **304** are configured to change airflow **204** moving relative to bay **108** when bay **108** is open to form desired airflow **306** when airflow **204** passes through louvers **304** in frame system **302**.

[0044] When one component is "physically associated" with another component, the association is a physical association in the depicted examples. For example, a first component, louvers **304**, may be considered to be physically associated with a second component, frame system **302**, by at least one of being secured to the second component, bonded to the second component, mounted to the second component, welded to the second component, fastened to the second

component, or connected to the second component in some other suitable manner. The first component also may be connected to the second component using a third component. The first component may also be considered to be physically associated with the second component by being formed as part of the second component, extension of the second component, or both.

[0045] In the illustrative example, frame system **302** and louvers **304** form spoiler **308** for aircraft **100**. An enlarged view of spoiler **308** in section **310** is described with respect to FIG. **4**.

[0046] With reference next to FIG. **4**, an illustration of an enlarged view of a frame system is depicted in accordance with an illustrative embodiment. In this figure, an enlarged view of section **310** with spoiler **308** is depicted.

[0047] As can be seen, frame system **302** in spoiler **308** is comprised of frame **400**, frame **402**, connector **404**, and connector **406**. Connector **404** is physically associated with frame **400** and connector **406** is physically associated with frame **402**. Connector **404** with frame **400** may be rotated in the direction of arrow **408**. Connector **406** with frame **402** may be rotated in the direction of arrow **410**.

[0048] As can be seen, louvers **304** are located within frame **400** and frame **402**. Louvers **304** are movable in these illustrative examples but may be fixed in other examples. For example, louver **412** in louvers **304** may be rotated in the direction of arrow **414** about axis **416** extending through louver **412**.

[0049] The movement of louvers **304** may change the direction of airflow **204** moving relative to bay **108** when bay **108** is open to form desired airflow **306** for airflow **204** when airflow **204** passes through louvers **304** in frame **400** and frame **402** in frame system **302**. Louvers **304** may be moved while aircraft **100** is at least one of on the ground or in the air. In other words, louvers **304** may be moved while the aircraft is stationary, moving on the ground, during flight, or some combination thereof. In other words, louvers **304** may be moved dynamically during operation of aircraft **100**.

[0050] As used herein, the phrase "at least one of," when used with a list of items, means different combinations of one or more of the listed items may be used and only one of each item in the list may be needed. In other words, "at least one of" means any combination of items and number of items may be used from the list but not all of the items in the list are required. The item may be a particular object, thing, or a category. For example, without limitation, "at least one of item A, item B, or item C" may include item A, item A and item B, or item B. This example also may include item A, item B, and item C or item B and item C. Of course, any combinations of these items may be present. In other examples, "at least one of" may be, for example, without limitation, two of item A; one of item B; and ten of item C; four of item B and seven of item C; or other suitable combinations.

[0051] Turning next to FIG. **5**, an illustration of a portion of frame system **302** is depicted in accordance with an illustrative embodiment. As depicted, an illustration of a portion of frame system **302** is shown. In this view, connector **404** has channel **500**, and connector **406** has channel **502**. Channel **500** may receive rod **504**, and channel **502** may receive rod **506**. Rod **504** and rod **506** are structures about which connector **404** with frame **400** may rotate in the direction of arrow **410**, and connector **406** with frame **402** may rotate in the direction of arrow **408** to move between a stowed position and an active position, or other positions in between.

[0052] Connector **404** is connected to link **508** and connector **406** is connected to link **510**, which may move to cause rotation of connector **404** and frame **400** about rod **504** in the direction of arrow **410** and may cause rotation of connector **406** and frame **402** about rod **506** in the direction of arrow **408**. Link **508** and link **510** may be connected to a motor, actuator, or some other movement system (not shown).

[0053] Turning next to FIG. **6**, an illustration of a laminar airflow redirected in a desired direction is depicted in accordance with an illustrative embodiment. In this illustrative example, a cross-sectional view of a portion of aircraft **100** with spoiler **308** taken along lines **6-6** in FIG. **4** is shown.

[0054] In this illustrative example, airflow **204** is a laminar airflow. A laminar airflow is a substantially uninterrupted flow of fluid, such as air, near a solid, such as lower outer mold line **112**. With a laminar airflow, the direction of the flow of the fluid remains substantially constant at every point in the flow of the fluid. This is in contrast to a turbulent flow in which the fluid flows such that the velocity at any given point in the flow of the fluid may vary erratically in magnitude and direction.

[0055] In this illustrative example, the redirection of airflow **204** to form desired airflow **306** pushes airflow **204** away from opening **110** of bay **108** while maintaining airflow as a substantially laminar airflow to form desired airflow **306** in this illustrative example. As can be seen, pocket **600** is formed. In this manner, an undesired turbulence in pocket **600** and cavity **201** within bay **108** may be reduced. With spoiler **308**, airflow **204** moves around bay **108** rather than into bay **108**.

[0056] Desired airflow **306** is in contrast to undesired airflow **602**. Undesired airflow **602** includes turbulence and may result in vortices and other undesired flow of air within bay **108**. This type of airflow is currently caused when spoilers are not used, spoilers are solid, or by spoilers that use holes.

[0057] With reference next to FIG. **7**, an illustration of a cross-section of louvers in a portion of a frame is depicted in accordance with an illustrative embodiment. In this figure, a cross-sectional view of louvers **304** in a portion of frame **402** is shown taken along lines **7-7** in FIG. **4**.

[0058] As depicted in this view, louvers **304** include louver **700**, louver **412**, louver **702**, louver **704**, louver **706**, louver **708**, and louver **710**. At least in this illustrative example, the louvers change the direction of airflow **204** to form desired airflow **306** when airflow **204** passes through louvers **304** shown in this view. In this example, the direction of airflow **204** is changed by angle **712** to form desired airflow **306**.

[0059] In particular, airflow **204** is directed away from lower outer mold line **112** of aircraft **100** in FIG. **1**. The direction of airflow **204** to form desired airflow **306** may reduce turbulence, vortexes, and other undesirable types of airflow within bay **108**. For example, airflow **204** may be directed at an angle away from lower outer mold line **112** of aircraft **100** to form desired airflow **306**. Additionally, desired airflow **306** also may reduce the possibility that payload **200** may become uncontrollable, contact aircraft **100** or both after being released from aircraft **100**. In other words, payload **200** becoming uncontrollable and/or contact between aircraft **100** and payload **200** may be avoided when payload **200** is released from aircraft **100** and exits bay **108** of aircraft **100** during flight.

[0060] In this illustrative example, desired airflow **306** is a laminar airflow and may be referred to as a redirected laminar airflow. This type of airflow generated using spoiler **308** with

frame system **302** and louvers **304** in frame system **302** is desirable in contrast to a turbulent airflow. Currently used spoilers that push the shear layer away from the cavity opening may generate a turbulent airflow which is undesirable in the illustrative examples.

[0061] With reference to FIG. **8**, an illustration of a movement system is depicted in accordance with an illustrative embodiment. In this figure, a phantom view of frame **402** in the direction of lines **8-8** in FIG. **4** is shown.

[0062] In this exposed view, motor **800** and worm gear system **802** are seen. Worm gear system **802** is an example of a movement system that may be used to move louvers **304**.

[0063] As seen in this view, worm gear **804**, worm gear **806**, and worm gear **808** are connected to motor **800**. Also, worm gear **804** engages positioning gear **810** on louver **700**; worm gear **806** engages positioning gear **812** on louver **412**, positioning gear **810** on louver **412**, and worm gear **808** engages positioning gear **814** on louver **702**. In this illustrative example, rotation of worm gear system **802** in the direction of arrow **816** causes rotation of louver **700** about axis **818**, louver **412** about axis **416**, and louver **702** to about axis **820**.

[0064] Turning next to FIG. **9**, an illustration of a movement system is depicted in accordance with an illustrative embodiment. As shown, worm gear system **802** has rotated in the direction of arrow **900**. This movement causes rotation of louvers **304** about their respective axes in the direction of arrow **902**.

[0065] In FIG. **10**, an illustration of a frame that moves about an axis is depicted in accordance with an illustrative embodiment. In addition to movement of louvers **304** within frame system **302**, frame system **302** also may move about a number of axes to move to a desired orientation when frame system **302** is outside of bay **108**.

[0066] In this illustrative example, frame **400** and frame **402** may rotate about axis **1000**. This rotational movement occurs where frame **400** is connected to connector **404** and frame **402** is connected to connector **406**. This type of movement may be implemented using any suitable type of movement system such as a motor, an actuator, and other suitable components.

[0067] Turning next to FIG. **11**, another illustration of a frame that moves about another axis is depicted in accordance with an illustrative embodiment. As depicted in this example, frame **400** may rotate about axis **1100**. Frame **402** may rotate about axis **1102**.

[0068] The movement in FIGS. **10-11** may be implemented using any suitable type of movement system. The movement system may include components such as, for example, at least one of a motor, an actuator, a pulley, care system, and other suitable components. The movement of frame **400** and frame **402** in frame system **302** may provide for additional capabilities to redirect airflow **204** to form desired airflow **306**. Further, other types of movement of frame **400** and frame **402** also may occur. In another illustrative example, movement of these frames may be linear rather than rotational depending on the particular implementation. Further, multiple types of movement may be present about or along one or more axes depending on the particular implementation.

[0069] Turning next to FIG. **12**, an illustration of cross-sections of louvers is depicted in accordance with an illustrative embodiment. Louvers **304** may take various forms and have different cross-sections. In the illustrative examples, a louver may be an elongate member that may change the airflow. In particular, a louver may be an elongate member that may change the direction of airflow as the airflow passes by the louver.

[0070] As depicted, cross-sections **1200** are examples of cross-sections that may be used to implement louvers **304**. In this illustrative example, cross-sections **1200** include cross-section **1202**, cross-section **1204**, cross-section **1206**, and cross-section **1208**. These cross-sections are examples of airfoils that may be used for louvers **304**. Cross-section **1210** is circular and cross-section **1212** is oval. The different cross-sections shown in cross-sections **1200** are presented merely as examples of shapes that may be used to implement louvers **304**. Other types of cross-sectional shapes may be used in other illustrative examples. Further, louvers **304** may use all of the same type of cross-sectional shapes or may use different types of cross-sectional shapes depending the particular implementation. Different groupings of louvers in a section of a frame may have a different cross-section from other groupings of louvers in another portion of a frame or in a different frame. Further, the size of the cross sections may vary along the length of a louver.

[0071] The illustration of aircraft **100** and airflow management system **202** in FIGS. **1-12** are presented as illustrative examples of an apparatus for managing an airflow. These examples are not meant to limit the manner in which other illustrative examples may be implemented. Other illustrative examples may include, for example, a single frame, three frames, or some other suitable number of frames in a frame system. Further, although the movement of louvers **304** is shown using a movement system in the form of a motor and other components, the movement of louvers **304** may be performed by a human operator while aircraft **100** is on the ground in other examples.

[0072] Turning now to FIG. **13**, an illustration of an airflow management system is depicted in the form of a block diagram in accordance with an illustrative embodiment. Components in airflow management system environment **1300** may be implemented in an aircraft, such as aircraft **100** in FIG. **1**. As depicted, airflow management system environment **1300** includes airflow management system **1302** that may be used in aircraft **1304** to change airflow **1306** moving relative to bay **1308** in aircraft **1304** to form desired airflow **1310**. Bay **1308** may take different forms. For example, bay **1308** may be selected from one of a weapons bay, a cargo bay, a wheel well for landing gear, or some other suitable type of bay in aircraft **1304**.

[0073] As depicted, airflow management system **1302** is comprised of a number of components. In this illustrative example, airflow management system **1302** includes spoiler **1312**, movement system **1314**, controller **1316**, and sensor system **1318**.

[0074] Spoiler **1312** is comprised of frame system **1320** and louvers **1322** that are physically associated with frame system **1320**. As depicted, frame system **1320** may include group of frames **1323**. As used herein, a "group of" when used with respect to items mean one or more items. For example, a group of frames **1323** is one or more frames.

[0075] Frame system **1320** is configured to move relative to bay **1308** in aircraft **1304**. Louvers **1322** are configured to change airflow **1306** moving relative to bay **1308** when bay **1308** is open to form desired airflow **1310**. Desired airflow **1310** results in at least one of a desired level of noise, preventing payload **1324** from becoming uncontrollable, or avoiding contact between aircraft **1304** and payload **1324**

exiting aircraft **1304** from bay **1308**. In the illustrative example, the uncontrollability may be, for example, inability to control the trajectory of payload **1324** as payload **1324** exits bay **1308** towards a target. The uncontrollability may occur even though contact is avoided when airflow **1306** is not desired airflow **1310**.

[0076] In this illustrative example, desired airflow **1310** is a redirected laminar airflow moving relative to bay **1308**. Louvers **1322** change airflow **1306** such that turbulence in airflow **1306** is reduced when bay **1308** is open. When using spoiler **1312**, the turbulence is reduced in airflow **1306** as compared to not using spoiler **1312** or other currently available spoilers.

[0077] In this illustrative example, movement system **1314** is configured to move at least one of frame system **1320** or louvers **1322** within frame system **1320** to a desired orientation when frame system **1320** is outside of bay **1308**. For example, movement system **1314** is configured to move frame system **1320** between a stowed position and an active position. In the active position, louvers **1322** change airflow **1306** relative to the bay in a desired manner after the louvers are in airflow **1306** outside of bay **1308** when frame system **1320** is in the active position.

[0078] Movement system **1314** may be configured to move frame system **1320** about a number of axes to move to the desired orientation when frame system **1320** is outside of bay **1308**. Movement system **1314** also may be configured to move louvers **1322**. For example, movement system **1314** may move louvers **1322** when aircraft **1304** is located in a location selected from at least one of on a ground or in air.

[0079] In the illustrative example, sensor system **1318** may include group of sensors **1326**. Group of sensors **1326** is configured to detect the environment around the sensor and generate information used to control spoiler **1312**. A sensor in group of sensors **1326** may be selected from one of a sound sensor, an airflow sensor, a vibration sensor, a pressure sensor, or some other suitable type of sensor.

[0080] As depicted, movement system **1314** may be configured to move louvers **1322** in response to changes in airflow **1306** to obtain desired airflow **1310** moving relative to bay **1308** when bay **1308** is open and desired airflow **1310** results in at least one of a desired level of noise, preventing payload **1324** from becoming uncontrollable, or avoiding contact between aircraft **1304** and payload **1324** exiting aircraft **1304** from bay **1308**.

[0081] The illustration of airflow management system environment **1300** in FIG. **13** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be unnecessary. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment.

[0082] For example, movement system **1314** and controller **1316** may be a single block. In another illustrative example, sensor system **1318** may be omitted from airflow management system environment **1300**.

[0083] The different components shown in FIGS. **1-12** may be illustrative examples of how components shown in block form in FIG. **13** can be implemented as physical structures. Additionally, some of the components in FIGS. **1-12** may be combined with components in FIG. **13**, used with components in FIG. **13**, or a combination of the two.

[0084] Turning next to FIG. **14**, an illustration of a flowchart of a process for managing airflow for an aircraft is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **14** may be implemented in airflow management system environment **1300** in FIG. **13**.

[0085] The process begins by moving a spoiler into the airflow passing a bay of the aircraft when the bay is open (operation **1400**). The process then changes the airflow moving relative to the bay to form a desired airflow using louvers physically associated with a frame system in the spoiler (operations **1402**) with the process terminating thereafter.

[0086] With reference next to FIG. **15**, an illustration of a flowchart of a process for managing an airflow for an aircraft using an airflow management system is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **15** may be implemented using airflow management system environment **1300** in FIG. **13**. This process may be performed dynamically during operation of an aircraft to maintain a desired airflow passing by a bay for an aircraft.

[0087] The process begins by receiving information from a sensor system about a group of parameters with respect to airflow moving past a bay (operation **1500**). The parameters may be used to directly or indirectly identify characteristics about the airflow moving past a bay.

[0088] The sensor system may be sensor system **1318** in FIG. **13**. The parameters may include at least one of an amount of turbulence in the bay, the level of sound in the bay, vibrations in a structure in a bay, vibrations in a structure in a portion of the aircraft, temperature, and other suitable parameters. The parameter selected may be based on those that may be used to identify whether airflow passing the bay is a desired airflow.

[0089] A determination is made as to whether the airflow is a desired airflow using the group of parameters (operation **1502**). This determination may be made using a controller such as controller **1316** in FIG. **13**.

[0090] If the airflow is not a desired airflow, at least one of the louvers or the frame system in the spoiler is moved (operation **1504**) with the process then returning to operation **1500**. In operation **1502**, if the airflow is a desired airflow, the process also returns to operation **1500**.

[0091] In this manner, the management of the airflow may be performed dynamically. In other words, adjustments may be made to the spoiler during operation of the aircraft to maintain a desired airflow.

[0092] The illustrative embodiments of the present disclosure may be described in the context of aircraft manufacturing and service method **1600** as shown in FIG. **16** and aircraft **1700** as shown in FIG. **17**. Turning first to FIG. **16**, an illustration of an aircraft manufacturing and service method is depicted in the form of a block diagram in accordance with an illustrative embodiment. During pre-production, aircraft manufacturing and service method **1600** may include specification and design **1602** of aircraft **1700** in FIG. **17** and material procurement **1604**.

[0093] During production, component and subassembly manufacturing **1606** and system integration **1608** of aircraft **1700** in FIG. **17** takes place. Thereafter, aircraft **1700** in FIG. **17** may go through certification and delivery **1610** in order to be placed in service **1612**. While in service **1612** by a customer, aircraft **1700** in FIG. **17** is scheduled for routine maintenance and service **1614**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

[0094] Each of the processes of aircraft manufacturing and service method **1600** may be performed or carried out by a system integrator, a third party, an operator, or some combination thereof. In these examples, the operator may be a customer. For the purposes of this description, a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, and suppliers; and an operator may be an airline, a leasing company, a military entity, a service organization, and so on.

[0095] With reference now to FIG. **17**, an illustration of an aircraft is depicted in the form of a block diagram in which an illustrative embodiment may be implemented. In this example, aircraft **1700** is produced by aircraft manufacturing and service method **1600** in FIG. **16** and may include airframe **1702** with a plurality of systems **1704** and interior **1706**. Examples of systems **1704** include one or more of propulsion system **1708**, electrical system **1710**, hydraulic system **1712**, and environmental system **1714**. Any number of other systems may be included. Although an example of an aircraft is shown, different illustrative embodiments may be applied to other industries, such as the automotive industry. Apparatuses and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **1600** in FIG. **16**.

[0096] In one illustrative example, components or subassemblies produced in component and subassembly manufacturing **1606** in FIG. **16** may be fabricated or manufactured in a manner similar to components or subassemblies produced while aircraft **1700** is in service **1612** in FIG. **16**. As yet another example, one or more apparatus embodiments, method embodiments, or a combination thereof may be utilized during production stages, such as component and subassembly manufacturing **1606** and system integration **1608** in FIG. **16**. One or more apparatus embodiments, method embodiments, or a combination thereof may be utilized while aircraft **1700** is in service **1612**, during maintenance and service **1614** in FIG. **16**, or both.

[0097] For example an airflow management system may be used during operation of aircraft **1700** when aircraft **1700** is in service **1612**. In another illustrative example, an airflow management system may be added to aircraft **1700** during maintenance and service **1614**.

[0098] The use of a number of the different illustrative embodiments may substantially expedite the assembly of aircraft **1700**, reduce the cost of aircraft **1700**, or both expedite the assembly of aircraft **1700** and reduce the cost of aircraft **1700**. For example, the cost of aircraft **1700** may be reduced through fuel savings, reduced maintenance, or both in the illustrative examples.

[0099] Thus, the illustrative embodiments provide a method and apparatus for managing airflow for an aircraft. A spoiler in an airflow management system may change the direction of airflow such that the airflow passing through the spoiler becomes a desired airflow. The redirection in the illustrative examples is caused by louvers in a frame system for the spoiler. The redirection is in contrast to current spoilers that push the airflow around the spoiler in a manner that causes turbulence rather than redirecting the airflow as it passes through the spoiler.

[0100] With an illustrative embodiment, the recirculation of air in a bay of an aircraft may be reduced. Also, a payload may move a desired distance away from an aircraft before reaching an airstream in a manner that reduces the likelihood of at least one of a payload becoming uncontrollable or a payload contacting the aircraft again after being released. Also, the likelihood a payload having a desired trajectory to reach a target is increased. Additionally, using a spoiler in accordance with an illustrative embodiment may result in an ability to decrease the size of the spoiler that provides for a desired performance parameter, such as at least one of reduced noise or vibrations from a bay, preventing the separating payload from becoming uncontrollable, or avoiding contact of a payload exiting a bay with an aircraft during flight, or other suitable performance parameters.

[0101] The description of the different illustrative embodiments has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. Further, different illustrative embodiments may provide different features as compared to other desirable embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. An apparatus comprising:

a frame system configured to move relative to a bay in an aircraft; and

louvers physically associated with the frame system, wherein the louvers are configured to change an airflow moving relative to the bay when the bay is open to form a desired airflow.

2. The apparatus of claim **1**, wherein the desired airflow results in at least one of a desired level of noise, preventing a payload from becoming uncontrollable, or avoiding contact between the aircraft and the payload exiting the bay of the aircraft in flight.

3. The apparatus of claim **1**, wherein the desired airflow is a redirected laminar airflow moving relative to the bay.

4. The apparatus of claim **1**, wherein in being configured to change the airflow moving relative to the bay when the bay is open to form the desired airflow, the louvers change the airflow such that turbulence in the airflow is reduced when the bay is open.

5. The apparatus of claim **1**, wherein the frame system is configured to move between a stowed position and an active position and the louvers change the airflow relative to the bay in a desired manner after the louvers are in the airflow outside of the bay when the frame system is in the active position.

6. The apparatus of claim **1** further comprising:

a movement system configured to move at least one of the frame system or the louvers within the frame system to a desired orientation when the frame system is outside of the bay.

7. The apparatus of claim **6**, wherein the frame system is configured to move about a number of axes to move to the desired orientation when the frame system is outside of the bay.

8. The apparatus of claim **6**, wherein the louvers are moved when the aircraft is located in a location selected from at least one of on a ground or in air.

9. The apparatus of claim **6**, wherein the louvers are configured to move in response to changes in the airflow to obtain

the desired airflow moving relative to the bay when the bay is open and the desired airflow results in at least one of a desired level of noise, preventing a payload from becoming uncontrollable, or avoiding contact between the aircraft and the payload exiting the bay of the aircraft in flight.

10. The apparatus of claim **6**, wherein the louvers are moved based on a payload in the bay to be separated from the aircraft.

11. The apparatus of claim **1**, wherein the bay is selected from one of a weapons bay, a cargo bay, and a wheel well for landing gear.

12. An aircraft airflow management system comprising:

a group of frames configured to move between a stowed position in a bay of an aircraft and an active position outside the bay of the aircraft; and

louvers physically associated with the group of frames, wherein the louvers are configured to change an airflow relative to the bay after the louvers are in the airflow outside of the bay in a desired manner when the bay is open to form a desired airflow and the group of frames are in the active position and wherein the desired airflow results in at least one of a desired level of noise, preventing a payload from becoming uncontrollable, or avoiding contact between the aircraft and the payload exiting the bay of the aircraft in flight.

13. The aircraft airflow management system of claim **12**, wherein the group of frames is configured to move about a number of axes to move to a desired orientation when a frame system is outside of the bay.

14. The aircraft airflow management system of claim **12**, wherein the louvers are configured to move in response to changes in the airflow to obtain a desired airflow moving relative to the bay when the bay is open.

15. The aircraft airflow management system of claim **12**, wherein the desired airflow is a redirected laminar airflow moving relative to the bay.

16. The aircraft airflow management system of claim **12**, wherein in being configured to change the airflow moving relative to the bay when the bay is open to form the desired airflow, an increase in turbulence in the airflow is reduced.

17. A method for managing an airflow for an aircraft, the method comprising:

moving a spoiler into the airflow passing a bay of the aircraft when the bay is open; and

changing the airflow moving relative to the bay to form a desired airflow using louvers physically associated with a frame system in the spoiler.

18. The method of claim **17** further comprising:

moving the louvers within the frame system to a desired orientation when the frame system is outside of the bay.

19. The method of claim **17** further comprising:

moving the louvers within the frame system to a desired orientation prior to flight of the aircraft.

20. The method of claim **17** further comprising:

moving the frame system to a desired orientation when the frame system is in an active position outside of the bay, wherein the frame system is configured to move about a number of axes to move to the desired orientation when the frame system is outside of the bay.

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